Before the

NATIONAL TELECOMMUNICATIONS & INFORMATION ADMINISTRATION

Washington, D.C. 20230

In the Matter of	)	
	)	
Development of a National Spectrum Strategy	)	Docket No. NTIA-2023-0003
	)	
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COMMENTS OF ASTROSCALE U.S. INC.

April 17, 2023

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Astroscale U.S. ("Astroscale") hereby respectfully submits Comments to the National Telecommunications and Information Administration (NTIA) request for comments in the above-referenced proceeding.[1] Astroscale thanks NTIA for the opportunity to provide feedback for consideration during the development of a National Spectrum Strategy and subsequent Implementation Plan.

I. Introduction

At the time of writing this Comment, the United States is communicating with an object over 14.7 *billion* miles from Earth using radio spectrum.[2] The Voyager 1 spacecraft – launched in 1977 and presently the furthest man-made object from Earth – to this day continues its mission to explore the previously unreached cosmos and transmit information back to Earth.

Anyone searching for an exemplification of U.S. spectrum leadership need look no further than the example of Voyager 1. National prioritization of spectrum access for innovative space-based missions, evolution to flexible use and authorization frameworks, and collaboration with

[1] Request for Comments, Development of a National Spectrum Strategy, 88 Fed. Reg. 16244 (Mar. 16, 2023) [*hereinafter* NTIA RFC].

[2] *See* Jet Propulsion Laboratory, *Voyager: Mission Status*, NASA, https://voyager.jpl.nasa.gov/mission/status/ (last accessed Apr. 7, 2023).

national and international stakeholders have enabled the U.S. to lead worldwide commercialization of space while continuing to receive cosmic insight from an asset almost fifty years old and billions of miles from home.[3]

A National Spectrum Strategy to accelerate U.S. leadership and unleash innovation should build on these historic pillars of prioritization, evolution, and collaboration. First, the spectrum strategy should include mechanisms to identify spectrum-reliant technologies that are key to U.S. policy interests and promote and prioritize their access to spectrum. Additionally, the national spectrum strategy should empower evolution – including flexible access arrangements and sharing agreements. Finally, collaboration will be key across the years to understand currents needs, structures, and where the spectrum environment is headed.

II. The National Spectrum Strategy's "Spectrum Pipeline" Should Set High-Level Policy Objectives and Initiate Studies for Priority Missions and Service.

In the modern era, an incredible number of missions and services rely on spectrum access. NTIA has identified a few of them already, from advanced transportation technologies to Earth and space exploration.[4] Without a national vision to harmonize and assist policymakers, faint signals recounting spectrum needs of critical missions and services can go unnoticed, lost under a rising noise floor. Overall, the National Spectrum Strategy needs to provide clear strategic policy goals of spectrum management that set a long-term vision for spectrum in the U.S.[5]

[3] *See generally* Roger Ludwig & Jim Taylor, *Voyager Telecommunications* 13 DEEP SPACE COMMC'NS & NAVIGATION SERIES 37 (Oct. 2014) (describing the communications infrastructure of the Voyager missions).

[4] NTIA RFC, *supra* note 1, at 16245.

[5] *See* U.S. GOV'T ACCOUNTABILITY OFF., GAO-11-352, SPECTRUM MANAGEMENT: NTIA PLANNING AND PROCESSES NEED STRENGTHENING TO PROMOTE THE EFFICIENT USE OF SPECTRUM BY FEDERAL AGENCIES 16-7 (2011) (noting that the previous *Federal Strategic Spectrum Plan* was limited in long-range planning processes for the federal government, and that key elements and best practices of strategic planning include elements of identification of long-term goals and objectives, approaches or strategies to achieve goals, etc.).

Astroscale urges NTIA to craft a National Spectrum Strategy with a two-tiered policy system. At the first tier, NTIA should set high-level, long-term policy objectives that define a vision for spectrum management throughout the lifetime of the Strategy. The second tier would be composed of more granular policies that are updated periodically and call out for advancement of a specific mission or service that advances the long-term policy. As explored in the following subsections, a tiered policy system creates a Strategy with enduring vision, the ability to be updated periodically, and overall helps prioritize spectrum actions for the future.

A. Establishing High-Level Policy Objectives Will Maximize Benefits of a Spectrum Strategy.

NTIA has proposed that the first Pillar of a national spectrum strategy could be a "spectrum pipeline," or a mechanism to identify future non-federal and federal use of spectrum and the potential spectrum bands that the technology requires.[6] Astroscale agrees that Pillar #1 should include a "spectrum pipeline," but urges NTIA to recognize that Pillar #1 must include high-level policy objectives that the processing pipeline is created to enable.

The National Spectrum Strategy should establish long-term, high-level policy objectives to maximize benefits of spectrum management. Defining the Strategy's policy objectives helps prioritize what needs to go into a spectrum pipeline, will enable linkage between discrete missions or services and the national architecture, and reveal potential gaps or areas for improvement.[7] This first tier of policy objectives would remain touchstones over the life of the Strategy.

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[6] NTIA RFC, *supra* note 1, at 16245-6.

[7] *See* U.S. GOV'T ACCOUNTABILITY OFF., GAO-22-104537, SPECTRUM MANAGEMENT: NTIA SHOULD IMPROVE SPECTRUM REALLOCATION PLANNING AND ASSESS ITS WORKFORCE 17 (2022) (relaying NTIA officials expressed no guidance exists for the initial portion of the spectrum reallocation planning process; the Redbook procedures initialize after a decision has been made to reallocate a band). GAO recommended last year that NTIA adopt leading practices of program management related to effective planning; one such practice is "having a program management plan that is updated regularly." The description states – "The program management plan formally expresses the organization's concept, vision, mission, and expected benefits produced by the program; the plan also defines program-specific goals

The Administration should reference existing statutory direction and commenters' feedback when creating high-level policy objectives for the National Spectrum Strategy. Existing statutory language mandates certain high-level policies NTIA is expected to advance across the years, such as policies that foster national security and economic prosperity.[8] Additionally, using feedback received in this RFC and accompanying Listening Sessions, NTIA can identify high-level policies with general support.[9]

To conclude, Astroscale offers the following example of a first-tier, high-level policy objective for inclusion in the National Spectrum Strategy:

> PROMOTE SPACE-BASED TECHNOLOGIES. Space-based technologies are key to numerous federal and non-federal missions and services, from climate and weather monitoring to expanded internet connectivity. Use cases for space-based technologies are quickly expanding, in part due to the decreasing cost of launch and rapid commercialization of the low-Earth orbit. In order to maintain U.S. leadership in this critical domain, the United States will support radiocommunication connectivity for cutting-edge research and development, explore and expand flexible connectivity solutions, and promote coordination among government, academic, and commercial users. The U.S.G. will also engage with, and support, international efforts to facilitate the development and use of space-based activities.

The above example policy accomplishes several goals. First, "promote space-based technologies" is general enough to apply for the foreseeable lifetime of the Strategy, and thereby future-proof policy. While remaining general, the policy objective still provides guidance on what national spectrum management should be targeted to achieve – U.S. leadership in space. Additionally, the policy objective is aligned with statutory direction to advance policies that foster national safety and security and economic prosperity; space hosts key military assets, such as GPS

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and objectives. The plan…communicates the linkage between the business strategy and the planned, prioritized work; reveals and explains the gaps; and provides a high-level view of key milestones and decision points." *Id.* at 18.

[8] 47 U.S.C. § 901(c) (2023).

[9] For example, feedback from the first Listening Session indicates that a high-level policy supporting flexible spectrum use has general support from industry.

satellites, and is a rapidly expanding commercial market.[10] Finally, as will be explored in the next subsection, a policy objective of "promote space-based technologies" is easily linked to discrete missions or services that should enter the spectrum pipeline and be the topic of second tier policies.

B. The Spectrum Pipeline Should Address Specific Missions or Services of Concern That Advance High-Level Policies.

Astroscale encourages NTIA to include a two-tiered policy system under the first Pillar of the National Spectrum Strategy. Discussed above, the Strategy should define first-tier policy objectives that serve as touchstones for decision making throughout the lifetime of the Strategy. Additionally, Astroscale suggests there be a second tier, made up of more granular policies nested under appropriate first-tier objectives and suitable for revision over time.

A second tier of policy objectives is important for two reasons. First, one challenging aspect of designing a National Spectrum Strategy is balancing a long-term strategic vision and against change over time.[11] The Strategy needs a capability to be updated, reflecting the reality that technologies are developed and evolve, spectrum needs discovered, and progress made in the spectrum pipeline, all while the overarching Strategy is still in force. [12] Creating a two-tiered policy system within the Strategy promotes this balance; the secondary policy objectives can be updated bi-annually to reflect progress or new understanding, while high-level, future-proof policies remain undisturbed.

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[10] *See, e.g.*, Amy Walker, *Space Provides Key to Joint All Domain Command and Control*, U.S. Army (June 14, 2022), https://www.army.mil/article/257523/space_provides_key_to_joint_all_domain_command_and_control (noting ways the Army is enhancing network resiliency through space communications, and the desire for "solutions that can blend commercial and military SATCOM.").

[11] *See* U.S. GOV'T ACCOUNTABILITY OFF., GAO-11-352, *supra* note 5, at 9-13 (critiquing the 2008 *Federal Strategic Spectrum Plan* for not including a discussion of long term goals and objectives, as well as approaches or next steps for achieving those goals).

[12] *See* U.S. GOV'T ACCOUNTABILITY OFF., GAO-22-104537, *supra* note 7, at 19 ("Without maintaining a complete plan and regularly updating it, NTIA and other stakeholders, including federal agencies, may not have assurance that the many steps involved in reallocating spectrum are being anticipated and prepared for.").

Additionally, a second tier of policy objectives enables NTIA to logically pinpoint what missions or services need to enter the spectrum pipeline and track their advancement. The reallocation process has many steps, including identifying spectrum bands for study and possible reallocation, conducting feasibility studies, providing feedback to the executive branch and FCC, and then taking action to ensure implementation of a reallocation.[13] A second tier of policies identifies the end goal of the process for a specific mission or service – e.g., reallocate spectrum – and allows for an accompanying Implementation Plan to lay out steps to accomplish the goal.[14]

Take, for instance, the emergent in-space servicing, assembly, and manufacturing (ISAM) sector. ISAM capabilities include satellite life extension, refueling, in-orbit repair and relocation, orbital transport and transfer, debris collection and removal, construction of systems in-space, and transformation of raw or recycled materials – to name a few.[15] ISAM capabilities are valued by commercial industry and federal operators alike.[16] ISAM is how the U.S. builds a space infrastructure for the future.

ISAM services are a clear candidate for a second-tier policy in the National Spectrum Strategy. Not only are ISAM services plainly linked to U.S. commercial development in space and

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[13] *Id*. at 17-8.

[14] *See* NTIA RFC, *supra* note 1, at 16247 ("Implementation Plan").

[15] *See* NAT'L SCI. & TECH. COUNCIL, EXEC. OFF. OF THE PRESIDENT, IN-SPACE SERVICING, ASSEMBLY, AND MANUFACTURING NATIONAL STRATEGY 6 (2022), https://www.whitehouse.gov/wp-content/uploads/2022/04/04-2022-ISAM-National-Strategy-Final.pdf (emphasis added) [*hereinafter* ISAM National Strategy].

[16] *See* Frank Wolfe, *Tournear: Demand Likely to Grow for Commercial Deorbiting Systems*, VIASATELLITE (Apr. 5, 2023), https://www.satellitetoday.com/government-military/2023/04/05/tournear-demand-likely-to-grow-for-commercial-deorbiting-systems/ (Space Development Agency Director Derek Tournear noting that commercial orbit servicing models allow operators to accept more risk and make satellites more affordable because commercial services can remove dead satellites from orbit if needed); Sandra Erwin, *Military to Tap Commercial Industry for "Space Mobility" Services*, SPACENEWS (Feb. 21, 2023), https://spacenews.com/military-to-tap-commercial-industry-for-space-mobility-services/ ("The U.S. Space Force is looking for ways to support future military operations with nontraditional space transportation systems and on-orbit logistics, the head of the national security launch program said."); Sandra Erwin, *DoD Signaling Demand for Satellite Support Services in Geostationary Orbit*, SPACENEWS (July 25, 2022), https://spacenews.com/dod-signaling-demand-for-satellite-support-services-in-geostationary-orbit/ ("In-space satellite refueling and robotic servicing vehicles are two areas where DoD is expected to increase investments, Space Force Maj. David Ryan…told SpaceNews.").

national security infrastructure, but ISAM has also been the subject of *both* a National Strategy and Implementation Plan from the Office of Science and Technology Policy (OSTP).[17] The government attention doesn't end there – the FCC released a notice of inquiry specifically for ISAM last year, and the public docket it generated holds much insight into the importance of this industry and its technologies.[18] The executive branch has made clear its intent to foster ISAM services.

But there's one problem. ISAM vehicles, like all satellites, need radio spectrum to communicate – and they don't have any specific allocation.[19] The OSTP ISAM Strategy and Implementation Plan have *zero* mentions of the how the executive branch will foster spectrum access for ISAM. Moreover, the U.S. lost an important opportunity for international leadership and forward progress when it recently opposed ally's efforts to enable ISAM radiocommunications on the international stage.[20] The leadership of a National Spectrum Strategy is dearly needed to enable these technologies.

[17] NAT'L SCI. & TECH. COUNCIL, EXEC. OFF. OF THE PRESIDENT, IN-SPACE SERVICING, ASSEMBLY, AND MANUFACTURING IMPLEMENTATION PLAN (2022), https://www.whitehouse.gov/wp-content/uploads/2022/12/NATIONAL-ISAM-IMPLEMENTATION-PLAN.pdf; ISAM National Strategy, *supra* note 15.

[18] *See Space Innovation & Facilitating Capabilities for In-space Servicing, Assembly, and Manufacturing*, Notice of Inquiry, IB Docket Nos. 22-271 & 22-272, 87 Fed. Reg. 56365 (Sept. 14, 2022).

[19] *See* Comments of Astroscale U.S. Inc, IB Docket. Nos. 22-271 & 22-272 at 18-23 (Nov. 1, 2022), https://www.fcc.gov/ecfs/search/search-filings/filing/1101529825125 (noting that "ISAM spectrum operations do not have a perfect definitional fit with any presently-defined radiocommunication service") [*hereinafter* Comments of Astroscale U.S.].

[20] *See* Int'l Telecomm. Union [ITU], Doc. 4A/839-E, *United States of America: Proposal for CPM Text for WRC-23 Agenda Item 7, Topic L* (Sept. 7, 2022) (noting the U.S. objected to Working Party 4A establishing a Topic L on TT&C for NGSO in-orbit servicing spacecraft, and was of the view that it be removed from further consideration under draft CPM text for WRC23). The proposal for Agenda Item 7 Topic L was originally put forward a U.K. company and was supported by the U.K. *See* Int'l Telecomm. Union [ITU], Doc. 4A/7TopicL, *United Kingdom of Great Britain and Northern Ireland: Proposed Revision to Preliminary Draft CPM Text for WRC-23 Agenda Item 7, Topic L* (Sept. 7, 2022).

i. Spectrum Requirements of ISAM Missions Are Largely Understood and Ready for Reallocation Studies.

While Voyager 1 is a golden example of what we have accomplished, ISAM services herald what we *will* accomplish. ISAM missions are key to the U.S. space future, in low-Earth orbit (LEO) and beyond. Commercial in-space servicing has demonstrated the capability to extend the life of communications satellites,[21] and to create rideshare opportunities and increase flexibility in reaching a final orbit,[22] and will soon remove dead satellites and large debris threats to the environment.[23] All of these are services that can be procured by the U.S. Government to support federal missions. Additionally, in-space recycling and manufacturing will establish circular economies in LEO,[24] while assembly will support commercial space station expansion around the Earth and Moon.[25] The U.S. must actively champion ISAM's spectrum future if it hopes to capitalize on the next-generation of commercial space development.

Spectrum needs of present and medium-term ISAM missions, specifically those providing services or conducting rendezvous and proximity operations (RPO), are largely understood thanks

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[21] *See* Chris Gebhardt, *Mission Extension Vehicles Succeed as Northrop Grumman Works on Future Servicing/Debris Clean-up Craft*, NASASPACEFLIGHT (May 7, 2021), https://www.nasaspaceflight.com/2021/05/mev-success-ng-future-servicing/.

[22] *See, e.g.*, Jodi Sorensen, *Spaceflight Inc. Announces First Lunar and GEO Rideshare Mission: "GEO Pathfinder,"* Spaceflight (Sept. 14, 2021), https://spaceflight.com/spaceflight-inc-announces-first-lunar-and-geo-rideshare-mission-geo-pathfinder/ (publication announcing Spaceflight, a successful commercial provider of LEO rideshare opportunities, is developing GSO and cislunar capabilities as well); Jeff Foust, *Momentus Preparing for Vigoride Thruster Test as it Ships Next Vehicle*, SPACENEWS (Mar. 10, 2023), https://spacenews.com/momentus-preparing-for-vigoride-thruster-test-as-it-ships-next-vehicle/ (discussing testing of the new generation of Momentus' orbital transfer vehicle, and success of the May 2022 Vigoride-3 vehicle).

[23] *See* Rachel Jewett, *Astroscale, JAXA Partner for Debris Removal Project*, VIASATELLITE (Feb. 12, 2020), https://www.satellitetoday.com/innovation/2020/02/12/astroscale-jaxa-partner-for-debris-removal-project/; *see also Astroscale On Course for First UK National Mission to Remove Space Debris*, ASTROSCALE (Mar. 7, 2023), https://astroscale.com/astroscale-on-course-for-first-uk-national-mission-to-remove-space-debris/.

[24] *CisLunar Industries, Astroscale U.S. and Colorado State University Awarded $1.7M Contract by the U.S. Space Force*, ASTROSCALE U.S. (Feb. 22, 2023), https://astroscale-us.com/cislunar-astroscale-csu-awarded-spacewerx/.

[25] *See generally* Danielle Piskorz & Karen L. Jones, *On-Orbit Assembly of Space Assets: A Path to Affordable and Adaptable Space Infrastructure*, AEROSPACE CORP. (Feb. 2018), https://aerospace.org/sites/default/files/2018-05/OnOrbitAssembly_0.pdf (noting the beneficial uses of in-space assembly, current state-of-the-art, and needed future improvements).

to current missions and industry insight. Because these missions change orbital locations more commonly than current spacecraft, and use distinct sensor payloads to accomplish rendezvous and docking, the spectrum requirements are most easily understood by operational phase.[26]

> ***Nominal Operations – Combined Stack or Solo Flight.*** When an ISAM spacecraft is in solo flight, or part of a combined stack (Servicer and Client are connected; rideshare is still hosting Clients to deploy), communication needs are minimal.[27] This phase has similar telemetry, tracking, and command (TT&C) communication requirements as standard satellites in a given orbital regime – transmissions are typically in the tens of kbps. These communications are limited in time, on the order of minutes, and may be able to accept interference from other services.
>
> ***Proximity Operations.*** During general proximity operations – including inspection, rendezvous, approach, docking, etc. – continuous communication is needed. Continuous communications support live command and control necessary for sensitive orbital activities. The duration of continuous communication is estimated to be twenty-four hours for nominal RPO procedures in a geostationary orbit. The requirement of constant communication during proximity operations will be true of most ISAM missions in the near term. If or when such activities become fully autonomous and do not need to downlink imagery to be used by a human during the docking process, communications needs may lessen.
>
> Missions performing proximity operations require a higher data rate than at other times. Proximity operations are supported by varying sensors – commonly including LiDARs, optical cameras, infrared cameras, and radiolocation devices. These sensors enable characterization and safe approach with another spacecraft when it is within resolvable range. Presently, most imagery analysis is done on the ground, requiring up to 100 Mbps downlink data rates. Because transmissions during proximity operations are critical to the safety of the involved spacecraft, these communications cannot tolerate harmful interference. However, communications are limited in duration, meaning coordination is facilitated – for instance, a geostationary docking procedure for

[26] *See* Comments of Astroscale U.S., *supra* note 19, at 13-8.

[27] It should be noted that for solo spacecraft, the connection durations and frequency are at the lowest end of the proposed range; a couple to few times per day, likely thirty minutes or under. However, for spacecraft in a combined stack with a commercial Client, this phase has similar telemetry communication requirements as standard satellites in a given orbital regime.

life extension services requires approximately 24-hours of intensive communications *once every 3-5 years*.

In the long-term, spectrum needs for ISAM missions may change due to advances in two primary technologies. First, as on-board computing power of spacecraft increases, it is possible that on-board sensor resolution and autonomous operations may alleviate the requirement to downlink large amounts of data during proximity operations. Second, NGSO ISAM operations may be able to take advantage of the increased proliferation of commercial intersatellite link services to reduce their ground footprint.[28]

In addition to the bandwidth needs and link durations, ISAM missions also have insight to what spectrum would be beneficial for repurposing. In general, frequencies between 1 GHz – 12 GHz, or approximately S-band to the upper range of X-band, are preferable. This range of frequencies supports accurate TT&C, higher data rate requirements for sensor imagery communication, and is not subject to rain attenuation that may cause harmful interference during critical proximity and docking operations.[29] Additionally, there is a high availability of ground station infrastructure for an S-band uplink and X-band downlink communication pairing.

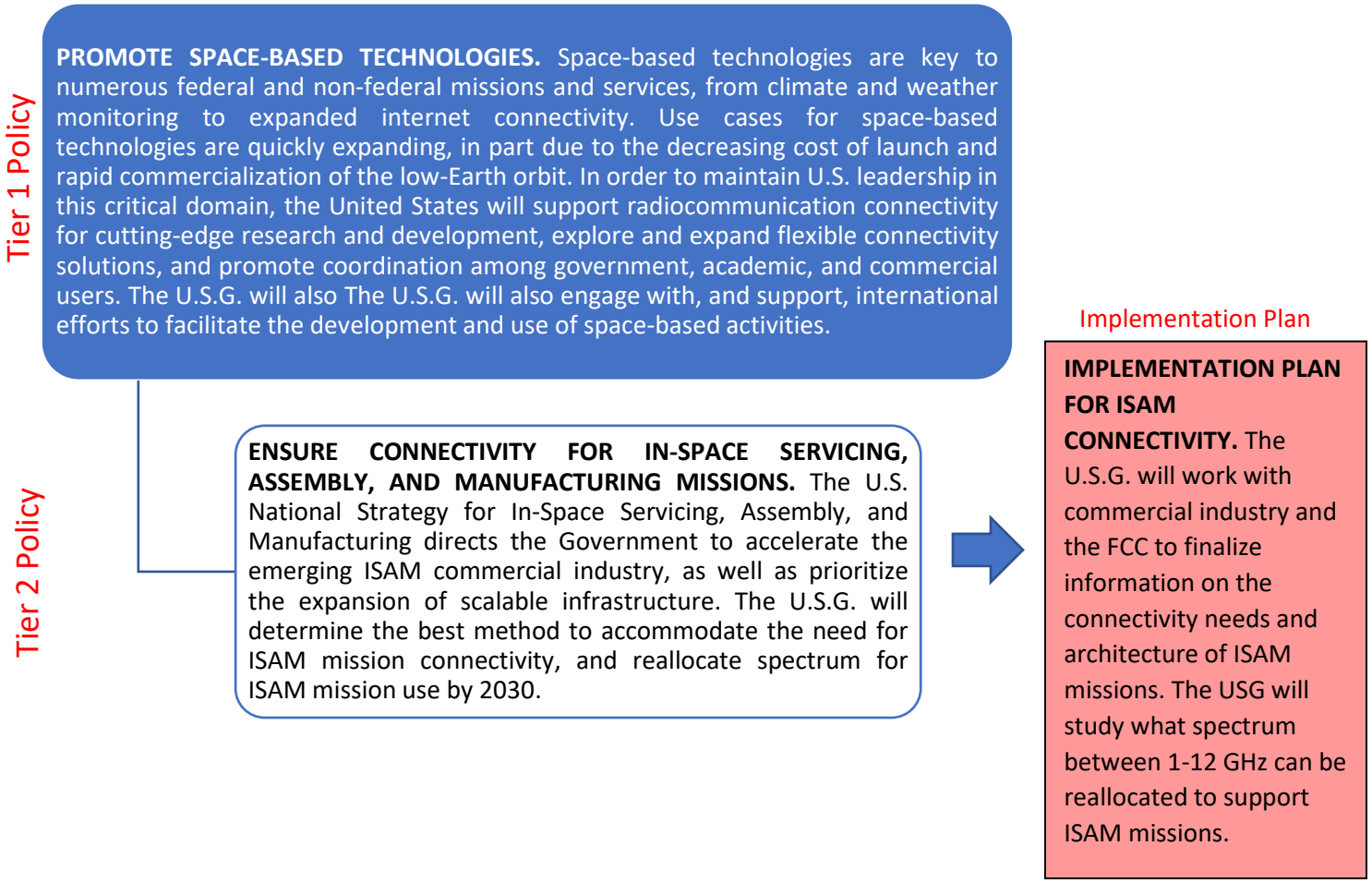
In conclusion, there is a significant understanding of what radiocommunication architecture is needed for current and near-term ISAM missions to succeed. Astroscale urges the Administration to promptly begin reallocation feasibility studies for spectrum. NTIA can collaborate with the FCC and industry through the FCC's public docket during this process, and partner with OSTP to create a wholistic ISAM Implementation Plan that includes facilitated access to spectrum.

[28] It should be noted that ISAM missions from geostationary orbit (GSO) and beyond, as currently understood, will not be able to take advantage of intersatellite links (ISLs). For one, the offered ILSs are pointing from the GSO arc towards the Earth, whereas servicing missions approach GSO satellites from above the GSO arc.

[29] *See* Comments of Astroscale U.S., *supra* note 19, at 13-7.

C. The National Spectrum Strategy Should Use a Two-Tier Policy Structure and Support Spectrum Reallocation for ISAM Missions.

NTIA should craft a National Spectrum Strategy with a two-tiered policy system and include ISAM missions in the spectrum pipeline. A high-level policy focused on expanding U.S. capabilities in the space domain is clearly responsive to NTIA's statutory mandate to advance policies related to national security, economic prosperity, and delivery of telecommunications – both critical and public. NTIA can then use second-tier policies to prioritize services and missions that the government has committed to advance, such as ISAM, and track their progress.



III. The National Spectrum Strategy Should Prioritize Flexible Spectrum Sharing Arrangements in a High-Level Policy.

Within the National Spectrum Strategy, NTIA should advance flexible spectrum sharing arrangements as a policy priority. Spectrum is growing increasingly congested, but technologies and sharing techniques for spectrum access mean more users than ever can take advantage of this critical resource. NTIA should craft a high-level policy that endures throughout the lifetime of the Strategy that calls for investigation, investment, and installation of sharing mechanisms.[30]

Regarding federal spectrum, it would be helpful for NTIA to gain a better understanding of what spectrum is being used, and when.[31] Understanding location and duration of use supports the creation of a sharing regime. This would be especially helpful when considering what allocations could support both federal and non-federal communications and coordinating transmissions.

For space users, the National Spectrum Strategy should support flexible access for potentially "non-conforming" spectrum uses.[32] Novel space technologies commonly face barriers of unallocated, or unclear, spectrum use. For instance, ISAM sensor payloads – such as optical and infrared cameras – operate above 1 THz; or, above radio spectrum that has been allocated. In these yet-unallocated ranges, the U.S. should permit flexible use and access arrangements to minimize barriers to entry for new in-space technologies. Additionally, new space missions have little clarity on what radiocommunication service they should operate within. ISAM data links are highly similar to uses contemplated under the Space Operation Service or Fixed-Satellite Service, but

[30] *See, e.g., Principles for Promoting Efficient Use of Spectrum and Opportunities for New Services & Promoting Efficient Use of Spectrum Through Improved Receiver Interference Immunity Performance*, Policy Statement, ET Docket Nos. 23-122 & 22-137 (draft released Mar. 30, 2023) (draft Policy Statement for adoption by the FCC, discussing sharing realities and policy goals for both transmitter and receiver components).

[31] U.S. GOV'T ACCOUNTABILITY OFF., GAO-22-104537, *supra* note 7, at 15-7.

[32] *See* Comments of the Commercial Smallsat Spectrum Management Association, IB Docket Nos. 22-411 & 22-271 at 2-3 (Mar. 3, 2023), https://www.fcc.gov/ecfs/search/search-filings/filing/103031332105998

sensor components may also be radiodetermination, Earth observation, or other services.[33] The National Spectrum Strategy should take the initiative and clearly support flexible spectrum access for ISAM missions within existing radiocommunication services, as appropriate.[34]

IV. The National Spectrum Strategy Should Include Ways to Promote Cooperation Amongst Federal and Non-Federal Spectrum Users.

Space is a new domain in which to research, innovate, and explore. The U.S. space economy is rapidly growing, as decreased launch costs, increased launch cadence, and advancements in modularized spacecraft enable rapid fabrication and deployment. The decreasing barriers to entry and continued opportunity for expansion mean that more and more new organizations are becoming space actors. Unfortunately, this expanding industry often has limited insight into spectrum coordination with heritage federal operators.

The rapid growth in new space actors should be accompanied by an increase in regular communications and information exchange between industry and government. The National Spectrum Strategy should foster efforts to facilitate those exchanges by building off of existing activities and creating new opportunities.

As demonstrated by the Commercial Smallsat Spectrum Management Association (CSSMA), there is a thirst for knowledge transfer between incumbent federal operators and new space operators. Since 2017, CSSMA has hosted "pre-coordination" meetings approximately twice a year. For these meetings, federal spectrum managers from various agencies graciously offer their time to meet with smallsat organizations and discuss the shared use of spectrum, typically S-band and X-band frequencies. These meetings have been an incredible source of insight into federal

[33] *See* Comments of Astroscale U.S., *supra* note 19, at 18-23.

[34] Astroscale does not rule out the possibility that further investigation may yield the conclusion that the U.S. needs to consider a new radiocommunication *service* if ISAM does not comport with defined radiocommunication services.

concerns and considerations and have offered federal spectrum managers the opportunity to learn about new and upcoming space entrants. The National Spectrum Strategy should consider formalizing a similar type of information exchange opportunity for space operators, federal and non-federal alike.

Additionally, the Consortium for the Execution of Rendezvous and Servicing (CONFERS) is a space industry group that offers insight to the needs and plans of the ISAM community. CONFERS publishes operational and technology standards collaboratively created by the international commercial ISAM community.[35] The National Spectrum Strategy should support consideration of global, industry-created standards like these when crafting policies to promote ISAM technologies.[36] CONFERS is also standing up an internal group specific to spectrum standards for ISAM missions. NTIA should encourage continued government involvement with this organization.

V. Conclusion

The U.S. leads in many areas of space, including communicating with the farthest man-made object from home. Spectrum management strategies for the coming decades can ensure continued leadership through future-proofed, high-level policies to prioritize work, flexible use arrangements, and improved coordination.

In summary, Astroscale specifically advocates that the National Spectrum Strategy:

- Establish long-term, high-level policy objectives that act as touchstones throughout the lifetime of the Strategy;
- Commit to ensuring spectrum access for ISAM, in line with existing executive policies;

[35] *See CONFERS Resources & Publications,* CONFERS (2020), https://www.satelliteconfers.org/publications/.
[36] NTIA RFC, *supra* note 1, at 16245.

- Support flexible spectrum access for ISAM missions within existing radiocommunication services, as appropriate; and
- Promote cooperation mechanisms for recurring exchanges between federal and non-federal space actors, such as pre-coordination meetings.

Astroscale thanks NTIA for this opportunity to comment on the creation of a National Spectrum Strategy and the importance of including in-space servicing, assembly, and manufacturing missions in the spectrum pipeline.

Respectfully submitted,

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